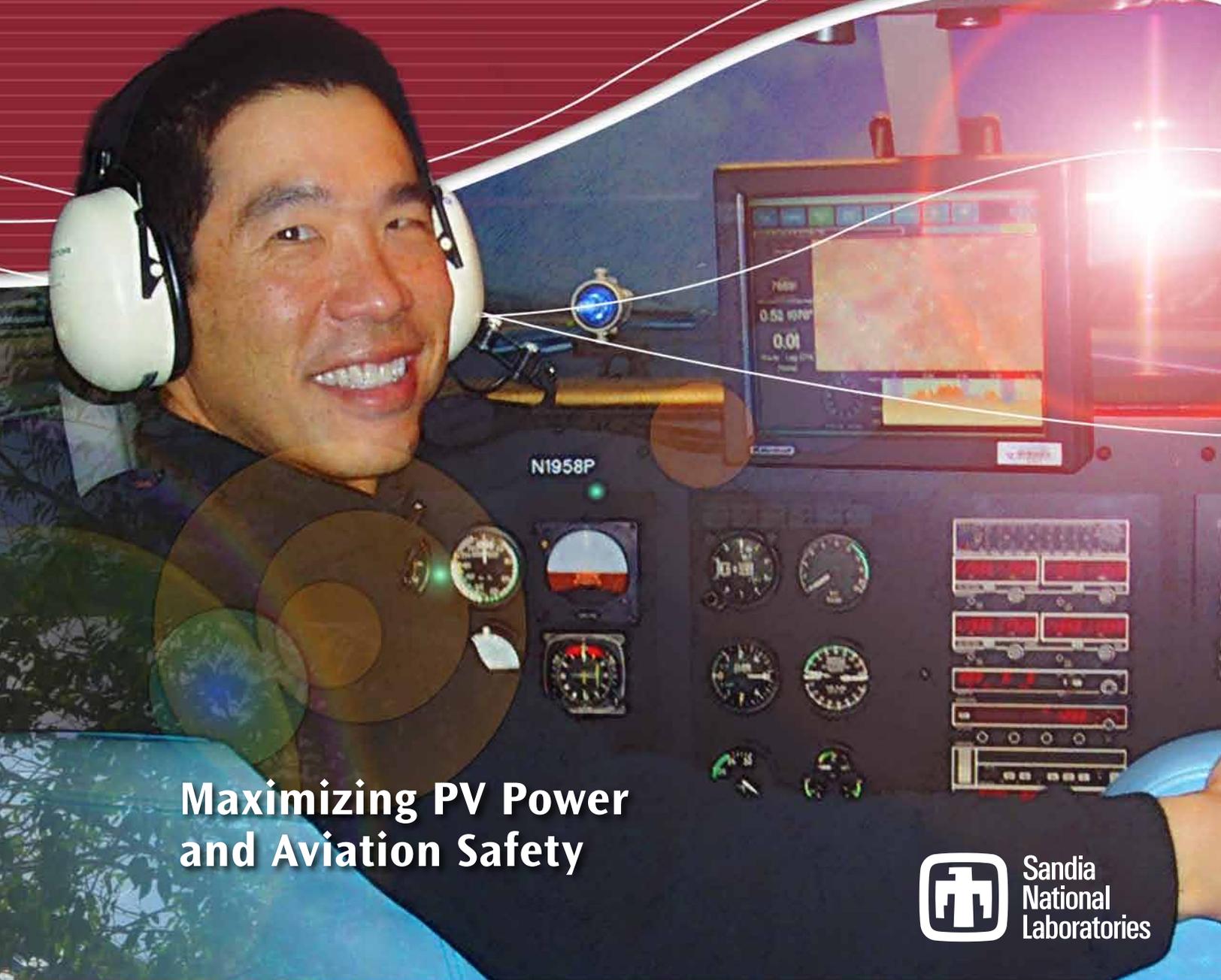


SANDIA NATIONAL LABORATORIES

# Partnerships

ANNUAL REPORT FY2012



**Maximizing PV Power  
and Aviation Safety**



**Sandia  
National  
Laboratories**

*“Initiatives such as Sandia’s Partnerships Program are critical for ensuring that the innovative technologies being developed at the national laboratories are reaching the marketplace to strengthen our national security, increase our economic prosperity, and protect our environment.”*

**Dr. Karina L. Edmonds**  
Technology Transfer Coordinator  
U.S. Department of Energy



*“Sandia’s partnerships help foster innovation in science and engineering to enable technology development and commercialization, ultimately helping to further strengthen our nation’s economic competitiveness and security.”*

**Dan Sanchez**  
DOE Technology Partnerships Manager  
NNSA Sandia Field Office



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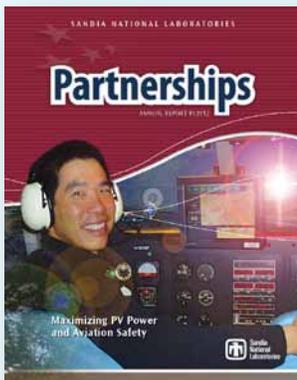
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#### About the cover:

Cliff Ho, Distinguished Member of Technical Staff, sits in a flight simulator at the FAA Civil Aerospace Medical Institute (CAMI) in Oklahoma City. Sandia is planning to conduct tests with CAMI to investigate the impact of glare on pilots. Factors such as glare duration and direction will be investigated and included in the Solar Glare Hazard Analysis Tool (SGHAT).

See story on page 18.

# Introduction



■  
**Dr. Julia M. Phillips**  
Deputy Chief Technology Officer and  
Director, Research Strategy & Partnerships (Former)  
Vice President and Chief Technology Officer (Current)  
Sandia National Laboratories



■  
**Dr. Peter R. Atherton**  
Senior Manager  
Industry Partnerships  
Sandia National Laboratories



■  
**Dr. J. Stephen Rottler**  
Vice President, Science and Technology  
and Chief Technology Officer (Former)  
Vice President, California Laboratory  
Energy, Climate & Infrastructure Security (Current)  
Sandia National Laboratories

# A Broad Spectrum of Partnerships Brings an Array of Benefits

Sandia partners with a broad spectrum of companies and organizations—big and small, local, national, and international. Some partnerships are with corporate giants, others with small startup businesses, universities, or government agencies. Partnerships can be with organizations in the local community, those across the country or around the world. In all cases, the point of the partnerships is to deploy technology for the U.S. public good.

In this FY2012 report you'll learn about a few of the many achievements and activities of the Sandia Partnerships Program including:

- Deploying specialized radar systems to benefit warfighters and create jobs
- Developing a new memory technology to enable faster supercomputers with lower energy appetites
- Researching carbon nanomaterials for the creation of advanced sensor systems
- Addressing climate change by accelerating the introduction of clean energy solutions
- Overcoming challenges related to the integration of renewable energy with the smart grid
- Commercializing sensor and coatings technology to improve public health and safety
- Improving the efficiency of product development at a leading manufacturing company
- Preventing solar installations at airports from creating hazardous glare while maximizing energy production
- Accelerating the development of solar electricity technologies for India and the U.S.

*“Sharing technology with the widest array of partners ensures that it will be used for the U.S. public good. Sandia’s Partnerships Program fulfills the Labs’ technology transfer mission, allowing innovations to be implemented, the economy to be enhanced, and new opportunities and collaborations to be created.”*

*Dr. J. Stephen Rottler  
Sandia National Laboratories*

- Improving on nanoparticle-based drug delivery by a millionfold
- Leveraging local and regional partnerships to promote technology transfer
- Fueling economic growth by showcasing the Labs’ technologies

With a new Intellectual Property strategy in place, thinking about how technology will be deployed is integrated into the earliest stages of the research and development lifecycle. In addition to supporting Sandia’s missions, technology is developed and disseminated through partnerships that result in new products or processes, improved public health and safety, and the creation of jobs.

While sharing technology for the U.S. public good, Sandia also benefits from partnerships. Working with partners provides researchers with opportunities to contribute to their respective fields, enhance the local and national economy, and help fulfill Sandia’s national security and technology transfer missions.

# General Atomics Aeronautical Systems

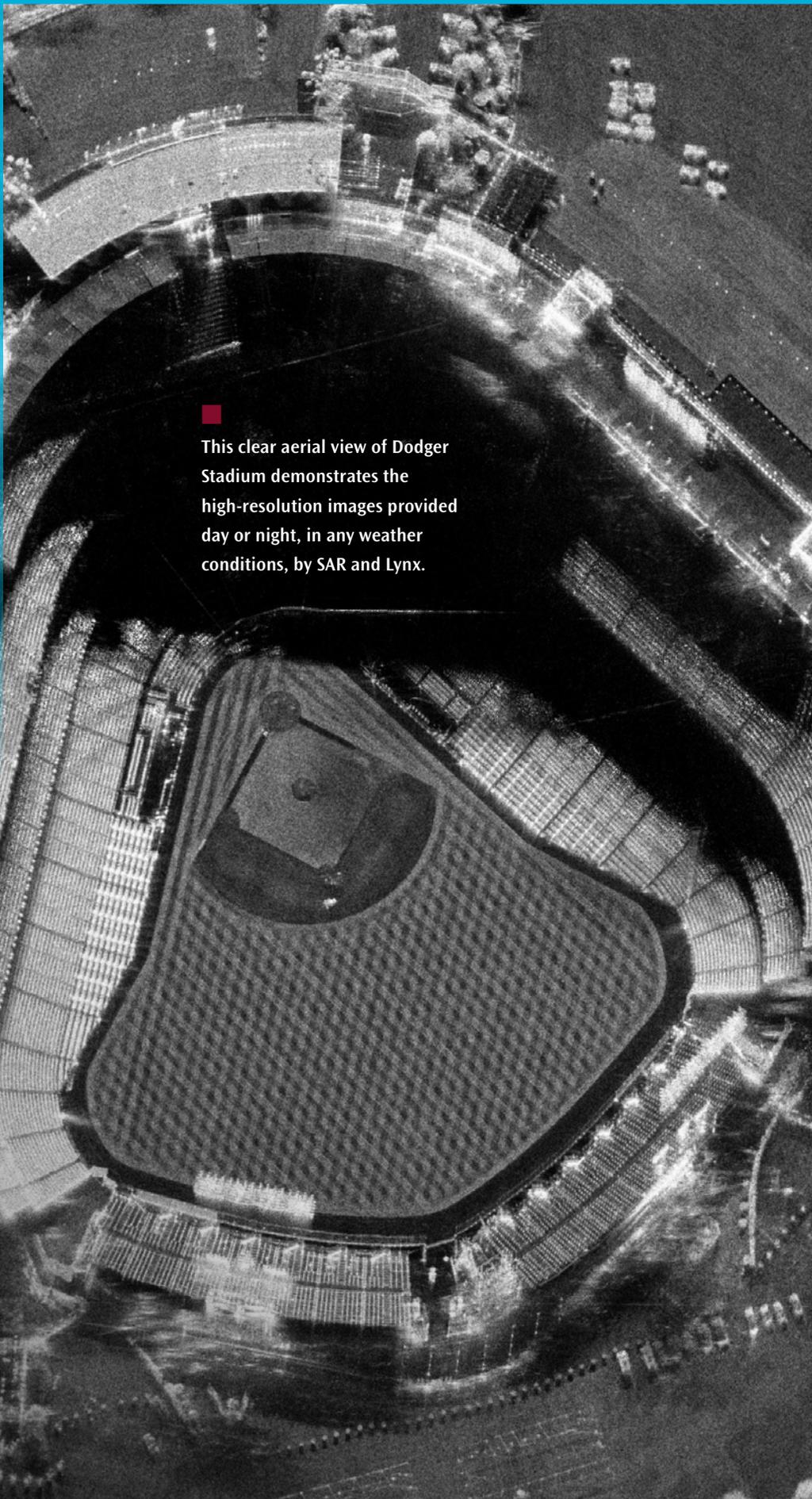
“Development of Lynx, with an operational fleet of over 200 radars, is a shining example of industry/national lab cooperation meeting the U.S. and allied airborne surveillance needs.”

**Linden Blue**

President

Reconnaissance Systems Group

GA-ASI

A high-resolution, grayscale aerial photograph of Dodger Stadium, showing the stadium's seating bowl, field, and surrounding urban area. The image is presented as a clear, high-resolution view, demonstrating the capabilities of SAR and Lynx technology.

■ This clear aerial view of Dodger Stadium demonstrates the high-resolution images provided day or night, in any weather conditions, by SAR and Lynx.

# Specialized Radar Systems Benefit Warfighters

In 1996 a Sandia National Laboratories engineer experimented on his own time with creating a web page. Simultaneously, General Atomics was looking for a high-performance radar system for its current and future Unmanned Aerial Vehicle (UAV) systems and discovered Sandia's radar experience and capabilities online.

A partnership began and continues to this day. Sandia and General Atomics Aeronautical Systems, Inc. (GA-ASI), an affiliate of privately held General Atomics, are working together to deploy Synthetic Aperture Radar (SAR) systems for the U.S. military and other customers. This partnership has resulted in immeasurable benefits to our warfighters, created jobs for the U.S., and spurred other technical advancements through an ongoing Cooperative Research and Development Agreement (CRADA).

SAR radar can make detailed, high resolution, photograph-like images of the ground from an aircraft, night or day, even in foggy, cloudy, or hazy conditions. The U.S. Air Force and other branches of the military use GA-ASI's Lynx® Multi-mode Radar systems. U.S. Department of Homeland Security, Customs and Border Protection also operates a fleet of UAVs, most equipped with Lynx systems.

General Atomics began marketing and producing the Lynx radar in 1999, and since then numerous improvements and new features have been implemented. Today, the radars are built by the GA-ASI Reconnaissance Systems

Group. Radar engineering, production, and business activities support nearly 700 employees spread across four buildings in Rancho Bernardo, California, and several other sites as well.

Through the CRADA, Sandia continues to support GA-ASI with development of new modes, features, and enhancements for existing radar systems, along with new product family members. In addition, Sandia assists with development testing and validation. The technological advances resulting from the creation of enhanced features and new products at GA-ASI also flow back to Sandia, benefitting other Sandia partners, too.

One 2012 development that Sandia and GA-ASI were involved with was a successful demonstration of additional features of the Maritime Wide Area Search (MWAS) mode of the Lynx Radar. The system's ability to support anti-piracy and counter-narcotics missions by detecting hard to find targets and relaying their imagery with metadata back to Navy commanders for dissemination and action was clearly demonstrated during Navy exercises off the coast of Southern California.

With both Sandia and GA-ASI having strong commitments to serving the military and law enforcement, this long-term relationship is a marriage with benefits to both partners. Sandia's expertise and intellectual property enhances GA-ASI's position as a world leader in radar systems. Sandia gains financial support through the CRADA which funds research and development efforts, and its engineers gain valuable real-world information and can share research discoveries through publication.

*“Our CRADA provides close interaction with Sandia’s broad expertise in materials, processing, and circuits, along with CMOS fabrication facilities. This partnership helps HP advance understanding of both basic device physics and novel applications for memristors.”*

**Dr. R. Stanley Williams**

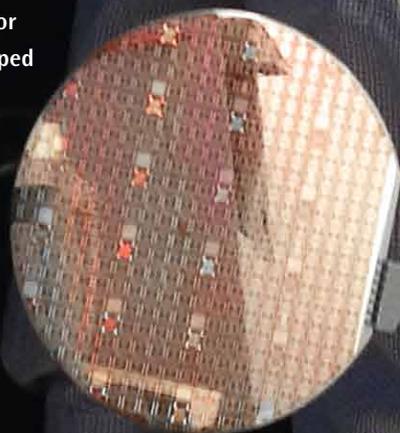
*HP Senior Fellow*

*Director Cognitive Systems Lab*

*Hewlett-Packard Laboratories*

*Hewlett-Packard Company*

■ Matt Marinella, Sandia Principal Member of Technical Staff, holding one of the first memristor test chip wafers fabricated using the CMOS compatible memristor process being collaboratively developed by HP Labs and Sandia.



## New Memory Type Speeds Exascale Supercomputers

A new nonvolatile memory technology that is much faster and uses less energy than flash memory is being developed by Hewlett-Packard Laboratories (HP Labs) in collaboration with Sandia National Laboratories. Called a memristor, short for memory resistor, this new technology can be a key enabler for exascale computing, advance neuromorphic computing, and provide reliable electronics for space.

Exascale computers would far exceed the capability of today's fastest supercomputers, whose speed is measured in petaflops. An exaflop is 1000 times faster than a petaflop. Power and memory are major issues in achieving these faster computers, and memristors have the potential to contribute toward solving both of these obstacles.

Today's supercomputers demand a tremendous amount of energy to operate, for example, IBM's Roadrunner, which in 2008 was the first supercomputer to break one petaflop in performance, uses enough energy to power about 5,000 homes. To achieve practical exascale computing, it will be necessary to limit the supercomputer's energy appetite while increasing its speed.

Sandia is looking at memristors, which are also referred to as resistive RAM or ReRAM, as a type of disruptive nonvolatile memory technology that could help make exascale computers practical in the long term. The goal, in part, is to create new computer architectures that are 100 to 1,000 times more energy efficient. These extraordinary improvements in energy efficiency will impact computing at all levels, providing us laptops and tablets with months of battery life.

Although the mathematical concept of memristors was proposed in 1971 as the fourth basic nonlinear circuit element by University of California, Berkeley professor Leon Chua, they are only now getting close to becoming commercially available. Physical proof of memristance finally became possible because it is easier to achieve in nanoscale devices. Researchers at HP Labs published their findings on memristors in *Nature* in 2008, and have been working towards commercialization since then.

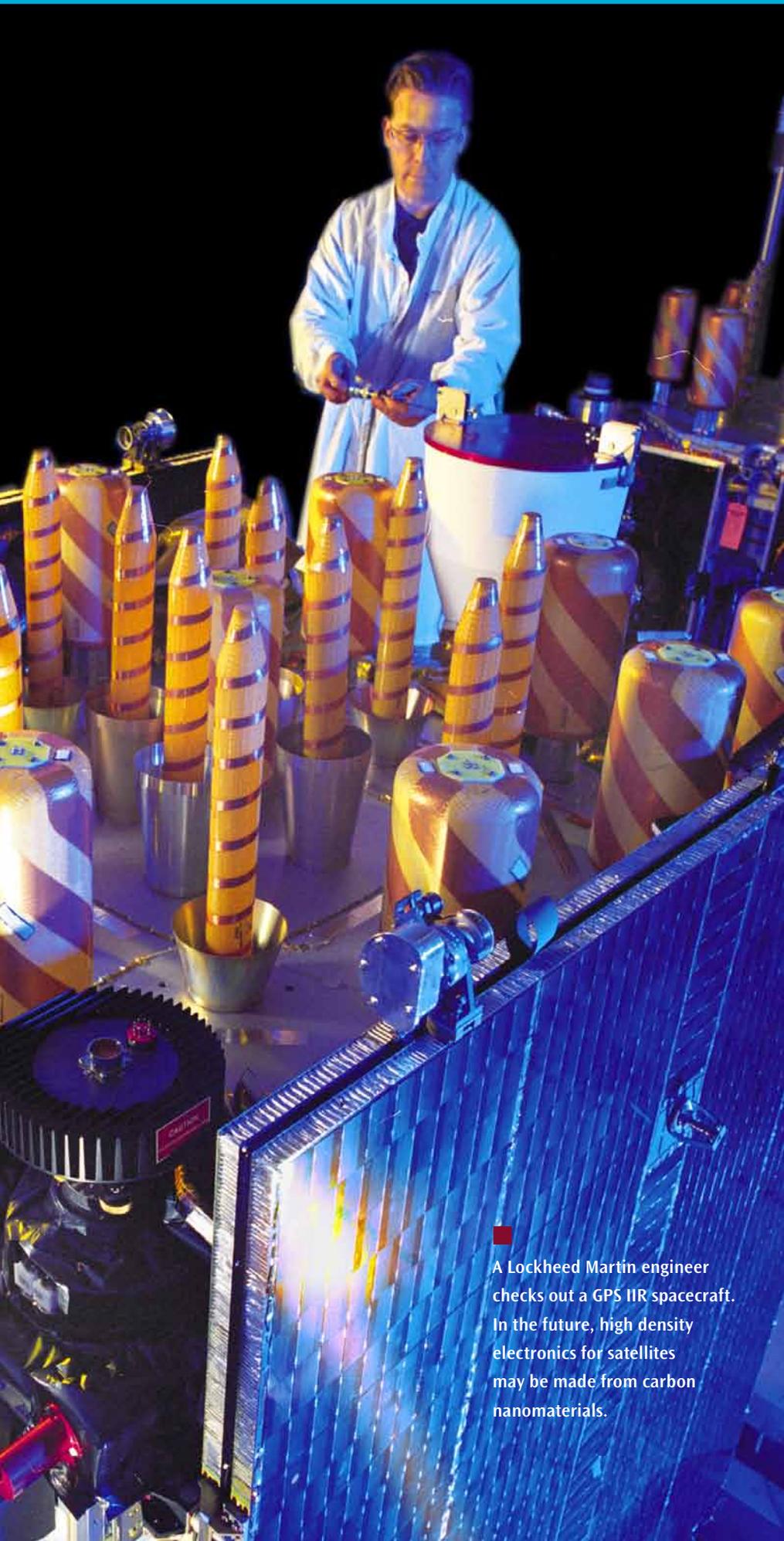
Memristors can be integrated with state-of-the-art Complementary Metal Oxide Semiconductor (CMOS) logic, and have the potential to flatten the traditional memory and storage hierarchy as well as provide some programmable logic applications.

Sandia has worked with HP Labs since the late 1980s on various projects. The latest Cooperative Research and Development Agreement (CRADA), signed by Sandia and HP Labs, allows HP to access Sandia's MESA Fab, an ideal facility for tackling the difficult challenges involved with integrating CMOS and memristor technology, which requires advanced R&D co-existing with a CMOS manufacturing line. Sandia and HP Labs are also jointly exploring concepts in circuit design, device testing, and materials characterization.

The two partners' interests are complementary. HP is aggressively pursuing memristors' commercial applications while Sandia sees clear value in pursuing them for government applications. At the same time, the science behind memristor operation is intriguing to both. Sandia has the expertise and facilities that augment HP Labs' analytical capabilities. Together, HP and Sandia will help each other achieve their goals.

*“Sandia is a world-class research institution with well-capitalized lab facilities and globally recognized thought leaders and research staff. This combination makes Sandia a good strategic fit for collaborations with the Lockheed Martin Space Systems’ Advanced Technology Center where we can bring extraordinary insight and value to each other in dynamic and rapidly advancing fields like nanotechnology.”*

**Dr. Kenneth Washington**  
Vice President  
Advanced Technology Center  
Lockheed Martin



■ A Lockheed Martin engineer checks out a GPS IIR spacecraft. In the future, high density electronics for satellites may be made from carbon nanomaterials.

# Disruptive Carbon Nanomaterials Studied for Sensor Potential

Nanomaterials present a new, disruptive advancement in electronics with their unique properties, and tantalize with visions of fast, compact electronics and sensitive optical detectors. As a world leader in defense and aerospace solutions, Lockheed Martin sees potential for the type of advanced electronics that nanomaterials promise across their solutions space, from advanced sensor systems enhancing situational awareness for the warfighter to high-density electronics for increased power in commercial satellites.

Lockheed Martin and Sandia National Laboratories have been collaborating for several years under Cooperative Research and Development Agreements (CRADAs) to harness the disruptive properties of nanomaterials, in particular those of carbon nanomaterials, such as carbon nanotubes and graphene. Within the family of nanomaterials, graphene is recognized as having exceptional potential.

Sandia is recognized as a world leader in nanotechnology, with unique capabilities in nanomaterials-based electronic and optoelectronic devices. The Labs' expertise includes the ability to synthesize and process carbon nanomaterials, and to characterize their properties using a number of techniques.

Once the properties are understood, Sandia nanotechnologists use different approaches to assemble the nanomaterial into nanodevices. These devices are then tested for their electronic and optoelectronic properties, and theory and modeling are used to understand the fundamental mechanisms that govern their operation. It is this breadth of experimental

approaches, combined with the unique integration of theory and modeling, that makes Sandia a strategic Lockheed Martin partner in nanotechnology.

While graphene has been touted as a carbon-based replacement for conventional materials, it lacks the electronic bandgap necessary to compete with silicon in semiconductor chips and transistors. In a recent collaboration, Lockheed Martin researchers with expertise in graphene synthesis and characterization have been working with Sandia to use nanoimprint lithography to pattern graphene to create nanometer features, which have been predicted to have the needed electronic bandgap.

The relationship between Sandia and Lockheed Martin is multi-faceted, providing value to both parties, as demonstrated by the broad portfolio of collaborative projects. Sandia offers world-class competencies from advanced materials and directed energy to microelectronics. Recent projects have drawn upon Sandia's unique infrastructure and expertise in creating, developing, and prototyping monolithic radio frequency optical filters; and in epitaxial growth, characterization, and modeling of compound semiconductors.

As a technology partner, Lockheed Martin has turned to Sandia over many years for applied technology, unique expertise, or facilities that Lockheed Martin does not possess internally. In turn, through these partnerships, Sandia realizes a goal that is important to both Sandia and the National Nuclear Security Administration (NNSA): maturing and transitioning national laboratory technology. Sandia values these collaborations, as Lockheed Martin provides real-world application pull for Sandia's technologies.



*“Having access to the unique capabilities and scientists at Sandia has had a profound impact on our work here at GEGR. The pre-competitive research funded by DOE is making a difference today on our product development plans to address the world’s need for sustainable energy.”*

**Dr. Gary Leonard**  
 Technology Director  
 GE Global Research

■ High performance computer clusters are used by CRF researchers, including Joe Oefelein, Distinguished Member of Technical Staff, to perform detailed simulations of combustion for transportation, propulsion and power devices.

# Addressing Climate Change with Clean Energy Solutions

GE is a longtime partner with Sandia National Laboratories, and with a new Umbrella Cooperative Research and Development Agreement (CRADA) in place, the Labs and GE are now working together more strategically to address huge issues such as climate change. Together, GE and Sandia are working to accelerate the introduction of clean energy solutions.

As a part of this partnership, GE and Sandia have set up a structure for successful collaboration which includes a set of parallel relationships, mechanisms for regular meetings, and a focus on a long-term agenda. Communication and trust are important parts of the partnership framework. GE is looking to replicate elements of this new framework in relationships with other national laboratories.

The relationship is focused on energy, with work on shared interests in the areas of combustion, high-performance computing, wind, and solar. Some near-term opportunities for collaboration include durable codes and faster algorithms for high performance computing; combustion modeling and validation for continuous flow devices like jet engines and turbines; low cost solar thermal systems; wind turbine and farm modeling; and combining renewable with traditional power generation.

One project coming from the partnership this year involved Sandia hosting PhD student Joseph Kocheemoolayil from Stanford University for an 8-week internship, where he

was working on his project to develop new, high-fidelity wind turbine blade noise simulation tools. Kocheemoolayil worked with Sandia's Matt Barone to run computational fluid dynamics simulations of blade noise using the Red Sky/Red Mesa supercomputer. They identified several important deficiencies of current blade noise models that need to be addressed in order to improve the accuracy of wind turbine noise predictions.

Another project has researchers at Sandia's Combustion Research Facility (CRF), GE Global Research, and GE-Aviation working together to create high-fidelity benchmark simulations of gas turbine combustion processes. The goal of this research is to improve efficiency and lower emissions of turbine engines. A series of high-fidelity calculations using the Large Eddy Simulation (LES) technique are being performed in a manner that leverages Sandia's and GE's combined expertise in LES, high-performance computing, and access to unique massively parallel computational facilities. The insights gained will provide a new and unique foundation for development of reduced models that are both accurate and affordable for engineering design.

There are benefits of the Sandia-GE relationship for both partners, and for the country. GE gains access to the Labs' researchers to combine their efforts with those of their own engineers. Sandia gains access to an industrial leader with a tradition of technical innovation that powers a quarter of the world. At the same time, the taxpayers' investments in technology research are amplified, having a potentially powerful effect on the U.S. economy.

“*Collaboration with Sandia has provided critical mass to several high-interest EPRI-utility research projects related to integration of distributed PV.*”

**Thomas S. Key**  
Technical Executive  
Power Delivery and Utilization  
EPRI

A man in silhouette is working on a large array of solar panels. The panels are blue with white grid lines, and the man is wearing a green shirt. The background is a bright, sunny sky.

■ Sandia researcher Josh Stein studies how clouds impact large-scale solar PV power plants.

# Integrating Renewable Energy with the Future Smart Grid

Photovoltaic (PV) systems will become an integral part of the future smart energy grid. But PV systems' output can be variable and have other characteristics that are different from traditional generation resources. Utility planners and operators are concerned with power system performance and reliability as deployment of variable generation increases.

Sandia National Laboratories and Electric Power Research Institute (EPRI) are collaborating through a Cooperative Research and Development Agreement (CRADA) to address challenges related to the integration of renewable energy systems such as PV and other distributed resources.

EPRI, an independent nonprofit organization, conducts research and development relating to the generation, delivery, and use of electricity for the benefit of the public. EPRI's members represent more than 90% of the electricity generated and delivered in the U.S., and international participation extends to 40 countries.

EPRI and Sandia have a mutual interest in addressing technical barriers related to large-scale deployment of PV systems. Sandia's experience leading industry activities, including the Solar Energy Grid Integration System (SEGIS), makes them an appealing collaborator in EPRI's utility-driven research program.

One of the tasks the partners are working on relates to developing performance standards for new grid interactive functionality for PV inverters. In order to achieve high deployment, PV needs to be a good "grid citizen" that will

support reliability. Standardizing test protocols that can be adopted by international standards organizations will help PV integrate with the smart grid. The development of standards also facilitates manufacturing and bringing renewable energy technology to market.

The development of accurate and sophisticated screening processes for the interconnection of new PV systems is another task funded by the California Solar Initiative, the U.S. Department of Energy (DOE) and EPRI. Results will help utilities to quickly identify situations where a detailed study may be justified because of risk to the grid, while allowing other, less threatening interconnections to be approved more quickly.

EPRI and Sandia are also conducting integration studies to quantify how much it will cost, from a bulk grid point of view, to integrate increasing numbers of residential and utility scale PV systems. To conduct these studies, data on simulated energy production at one minute intervals for an entire year were needed. Sandia applied techniques developed for other solar research being done at the Labs to provide the required data for a major EPRI-led PV integration study in Arizona.

Once a PV plant is built, what will it cost to operate and maintain it? Sandia is able to aggregate data EPRI collects from utility-owned PV plants to address this key question. Results derived from the analysis allow EPRI and Sandia to help utility companies and the public better understand PV plant reliability and costs.

The partners' efforts are helping to bring PV into the emerging smart grid world.

*“The Parker-Sandia partnership provided a foundation of material science and research that led to the commercialization of new technology and the development of a new instrument aimed at improving public health and safety.”*

**John Morse**

*New Business Development  
Manager*

*Instrumentation Products Division  
Parker Hannifin Corporation*

■  
Curtis Mowry, Sandia Materials Characterization Department, and Dr. Kazi Hassan (right), Water Applications Specialist, Parker Hannifin Corporation, work with the Parker THM Analyzer.

## New Water Analyzer Improves Public Health and Safety

On the winding road from basic research to commercial product, perseverance and serendipity often play a role along with scientific expertise. Such was the path for two separate Lab Directed Research and Development (LDRD) projects. The research led to the Parker THM Analyzer, a tabletop tool that lets water system operators easily measure potentially dangerous disinfection by-products (DBPs) in less than 30 minutes at their own facilities.

In 2005 Sandia researcher Curt Mowry presented the initial results of research using sensors for water safety at a water quality conference. Someone from the Parker Hannifin Corporation, who heard about the conference presentation from someone else, contacted Mowry. Sandia and Parker began working together in 2006 to develop a water analyzer under a Work for Others (WFO) agreement.

As research progressed on the use of Surface-Acoustic Wave (SAW) technology detectors in the water analyzer, Mowry learned about the LDRD work Mike Siegal, a Sandia researcher in another group, was doing with nanoporous-carbon (NPC), a new structural form of carbon developed by Siegal, as a SAW sensor coating. By using NPC as a sorbent material for SAW sensors instead of the more typical polymers, part-per-billion detection levels were achieved. This revolutionary breakthrough provided 1000 to 1 million times greater sensitivity for the detection of various chemicals and enabled a product that would be less expensive and more effective.

Chemical treatments for water disinfection started being used to reduce epidemics of diseases like cholera and typhoid 100 years ago. THMs are trihalomethanes, potentially dangerous by-products formed when disinfection agents, typically chlorine and bromine, react in water with trace natural organic matter. Today, microbial contaminants in water are still a health-risk challenge, so as water treatment continues, the formation of DBPs like THMs must be monitored.

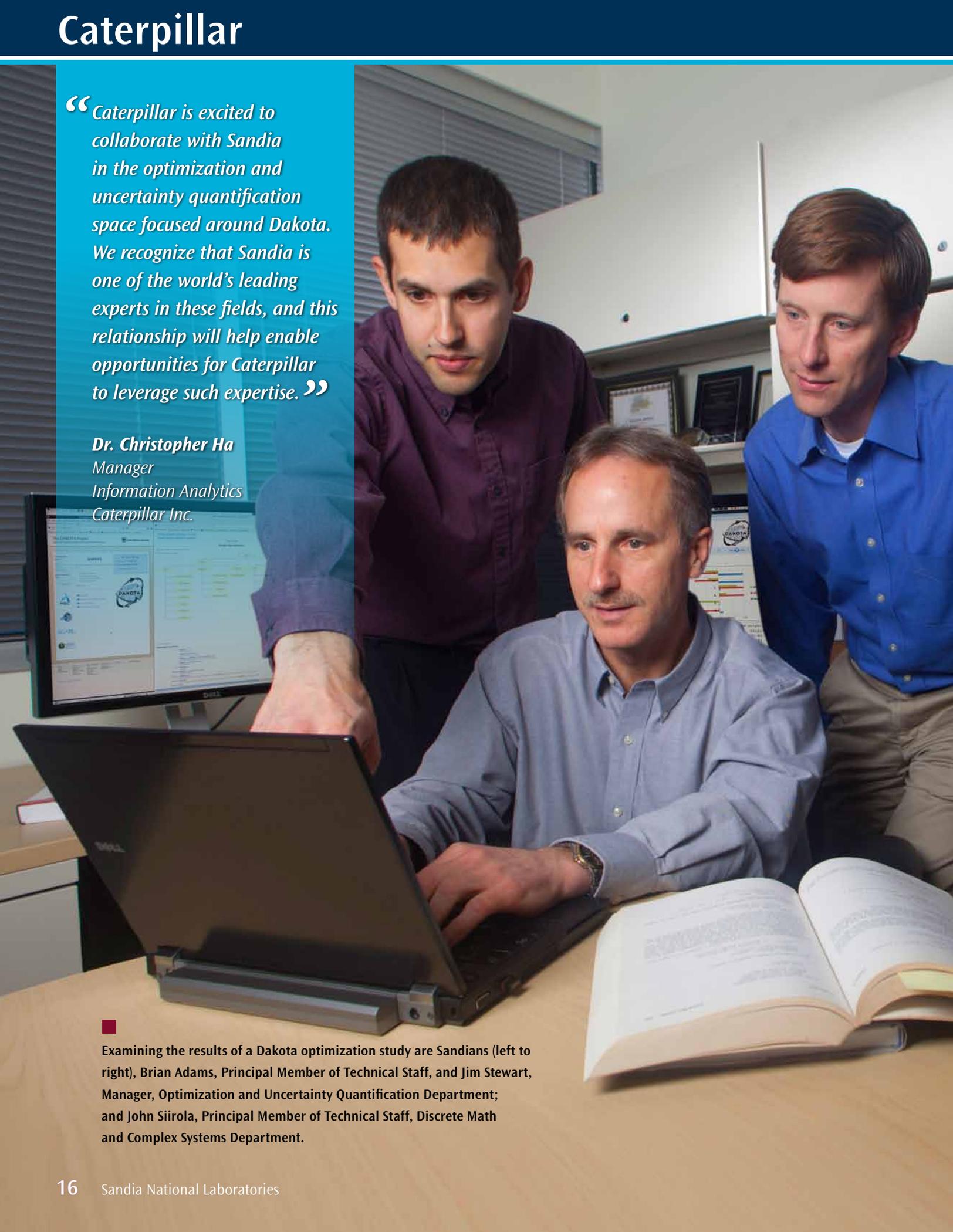
The U.S. Environmental Protection Agency Stage 2 Disinfectants and Disinfection Byproducts Rule began to be implemented in January 2012 to reduce potential cancer risks and address concerns with potential reproductive and developmental risks. By partnering with Sandia, Parker's THM analyzer was ready to meet water system operators' need to perform water analyses quickly, easily, and affordably.

Results from the Parker tabletop system are very accurate, comparable to those from large and expensive analytical laboratory equipment. Results are also fast, only minutes compared to days or weeks for samples sent out to labs for analysis. Water samples are simply collected in a vial that is screwed into the analyzer. The operator hits "start" and receives results.

Three hundred million people in the U.S. rely on public water systems for clean water. By working with Parker, Sandia is using its research to keep the public drinking water supplies safe. This technology is easily extendable for detection of other volatile organic and toxic industrial compounds at parts-per-trillion levels, so it can be used in additional ways for the public good.

*“Caterpillar is excited to collaborate with Sandia in the optimization and uncertainty quantification space focused around Dakota. We recognize that Sandia is one of the world’s leading experts in these fields, and this relationship will help enable opportunities for Caterpillar to leverage such expertise.”*

**Dr. Christopher Ha**  
Manager  
Information Analytics  
Caterpillar Inc.



Examining the results of a Dakota optimization study are Sandians (left to right), Brian Adams, Principal Member of Technical Staff, and Jim Stewart, Manager, Optimization and Uncertainty Quantification Department; and John Sirola, Principal Member of Technical Staff, Discrete Math and Complex Systems Department.

# Computer Simulations Cut Product Development Costs

In today's competitive global market, engineers are increasingly using computer simulations to determine optimal solutions to product design and system performance challenges. This helps them reduce dependence on prototypes and testing, which shortens design cycles, and reduces product development costs.

Sandia National Laboratories has developed software tools and computing expertise that help engineers with the virtual product development process. That's why industrial giant Caterpillar has expanded their relationship with Sandia through a strategic Umbrella Cooperative Research and Development Agreement (CRADA).

Sandia is assisting Caterpillar in developing and applying advanced technologies for managing change in the growing world of virtual product development. Sandia's technologies will provide advanced new capabilities to the decision makers at Caterpillar.

The world's leading manufacturer of construction and mining equipment, diesel and natural gas engines, industrial gas turbines, and diesel-electric locomotives, Caterpillar is a U.S.-based global leader and one of the 30 Dow Jones companies.

Past CRADAs between Caterpillar and Sandia have focused on single projects in diesel combustion, whereas this strategic Umbrella CRADA will allow for multiple projects.

Technical categories in the new CRADA include Simulation Design Exploration, Advanced

Analytics, Multi-physics Engineering Modeling and Simulation, and High-Performance Computing. The agreement includes training, education, technical support, and staff visits.

The first project under the CRADA focuses on optimization capabilities to apply to Caterpillar engineering designs. The work will involve Dakota, an open-source software tool developed by Sandia and already being used by Caterpillar. Sandia will collaborate with Caterpillar on tailoring Dakota to more closely suit their needs.

Another effort will combine the capabilities of Dakota and a newer software package, Pyomo (Python Optimization Modeling Objects), to provide a wider range of optimization capabilities. Pyomo is a Sandia-developed open-source tool for formulating and manipulating algebraic models within the Python programming environment.

The cornerstone of Caterpillar's business is its innovative technologies. As a large enterprise, it exercises complete control over the design and development of its own engines, hydraulics, electronics, and more.

Cooperative research with Sandia contributes to the company's ability to satisfy the increasing demand for more energy efficient industrial engines and equipment, while also advancing Sandia's energy and economic security missions.

The enduring relationship between Caterpillar and Sandia will continue to provide benefits for both the company and the nation.

# Blinded by the light

## *Glare Analysis Software Improves Aviation Safety*

■ PV panels, although designed to absorb sunlight, can produce glare in certain instances because of their glass surfaces. SGHAT helps select PV array configurations that will maximize annual energy production with minimal glare.

The number of solar energy installations is increasing, but to achieve the U.S. Department of Energy's (DOE's) goal of more than 10% penetration by 2030, tens of thousands more are needed. The land on airports is increasingly being seen as the perfect place for photovoltaic (PV) installations. Many airport sponsors desire solar PV installations so they can operate more sustainably using this renewable energy source. In other cases, solar PV installations provide an airport sponsor the ability to increase revenue by leasing the land for solar energy production.

While there are many advantages to having a solar PV installation on an airport, these arrays can create a glare hazard for pilots, air traffic controllers, or motorists. This is because the glass surfaces of solar PV panels, although

designed to capture as much sunlight as possible, can still produce glare.

To ensure the safety of the national air transportation system, the Federal Aviation Administration (FAA) is now requiring analysis of potential ocular hazards for new solar energy installations on an airport before they are permitted by the FAA.

Sandia National Laboratories developed a free, publicly available web-based software tool to address this issue. Funded by the DOE and supported by the FAA, the Solar Glare Hazard Analysis Tool (SGHAT) quantifies when and where glare will occur throughout the year. At the same time, SGHAT also helps select configurations that will maximize energy production.

*“Without your work and your support, we would definitely not have made the positive advances towards our operational guidance with regards to solar technology.”*

**Vincent Chirasello**

Manager, AFS-408

NextGen Field Program Office

Federal Aviation Administration



SGHAT is quick and easy to use. Unlike methods such as ray tracing, SGHAT takes only a few seconds, instead of hours or even days, to run an annual, minute-by-minute simulation. The outline of a proposed PV array is drawn on a web-based map. Once the tilt, orientation, and a few other parameters are entered, SGHAT calculates the potential ocular impact from user-prescribed observation points. A single point can represent a fixed location like an airport traffic control tower, and multiple points can be used to represent a flight path. The results are presented in an easy-to-interpret color-coded plot.

In 2012 SGHAT was used to help evaluate and permit the construction of on-airport solar PV arrays configurations at four airports, including

the Albuquerque Sunport. Assistant Airport Director, Manchester-Boston Regional Airport, Richard Fixler, PE, said, “We used this tool at our airport and found SGHAT to be very impressive in its utility, ease of use, accuracy, and output. It is a tool that can prove itself invaluable in the evaluation of solar projects, especially at airports.”

SGHAT also fulfills a need expressed by the United States Air Force, Department of Transportation, and the Solar Energy Industries Association for quantified analyses of glare to ensure safe permitting of solar power systems near airports, Department of Defense (DoD) military installations, roadways, and residences. Anyone can register to use the free online SGHAT tool at [www.sandia.gov/glare](http://www.sandia.gov/glare).

■ Characterization of PV panel reflectances for use in SGHAT (inset).

“SERIIUS provides the right platform for integrating core research competence to develop next generation solar electric systems. As a world leader in CSP, Sandia’s partnership will play a pivotal role in developing game-changing technologies in high efficiency distributed solar power.”

**Dr. Pradip Dutta**  
Professor of Mechanical  
Engineering  
Indian Institute of Science  
Bangalore



■ Allison Gray, Engineer I for NREL’s Concentrating Solar Power Research Division, maneuvers a Flabeg RP 2 mirror.

# Accelerating Solar Electricity Technologies for India and the U.S.

The Solar Energy Research Institute for India and the United States (SERIIUS) is a joint research consortium for accelerating solar electricity development. SERIIUS plans to achieve its goal by lowering the cost per watt of photovoltaics (PV) and concentrating solar power (CSP).

The vision of SERIIUS, co-led by the Indian Institute of Science at Bangalore (IISc) and the National Renewable Energy Laboratory (NREL), is to create an environment for cooperation and innovation “without borders” to develop and ready emerging and revolutionary solar electricity technologies toward the long-term success of India’s Jawaharlal Nehru National Solar Energy Mission and the U.S. Department of Energy (DOE) SunShot Initiative.

The SunShot Initiative drives research, manufacturing, and market solutions to make the abundant solar energy resources in the United States more affordable and accessible for Americans. India’s National Solar Energy Mission has similar goals directed to ensuring energy security and affordability for India.

With a long history of expertise in CSP, and one of the few solar power towers in the world, Sandia National Laboratories is working as a research lead, collaborating with NREL and IISc, on one of SERIIUS’ three primary research thrusts, multiscale CSP.

SERIIUS has identified high-efficiency, scalable, distributable CSP as a key focus. The research aims to reduce the levelized cost of energy

(LCOE) by increasing the efficiency of the power cycle and reducing the costs of solar collectors with innovative designs and optical materials. Sandia will be performing a number of research activities to help meet these objectives.

In one task, Lab researchers are investigating a higher efficiency energy cycle that will help power plants using CSP as an energy source produce more power. Currently, the maximum thermal to electric conversion efficiency of CSP steam power plants is around 42%, and Sandia researchers are trying to achieve over 50% by considering the use of closed CO<sub>2</sub> Brayton cycles. Sandia will be designing and analyzing high-temperature solar receivers that can capture the concentrated sunlight for these power cycles.

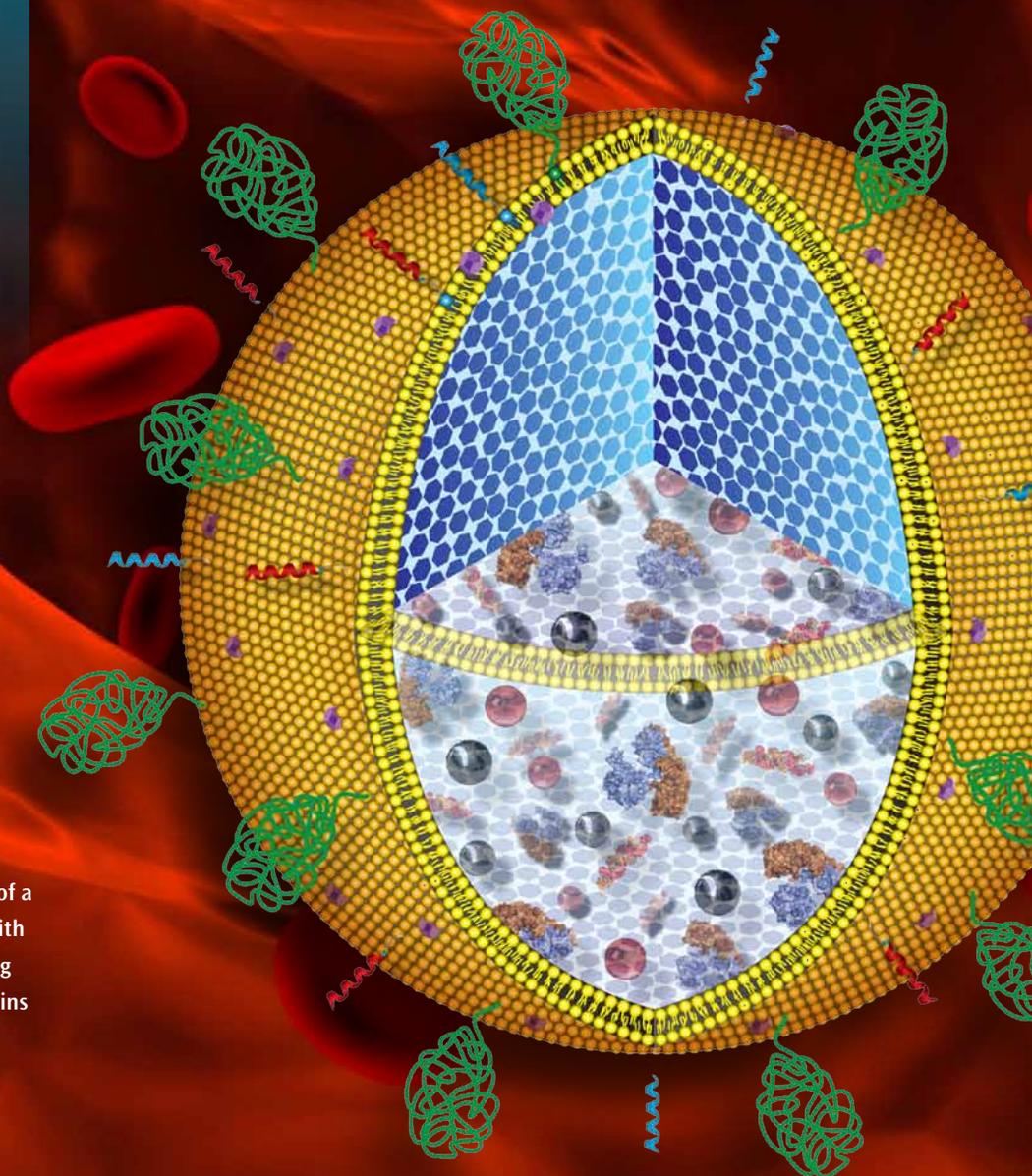
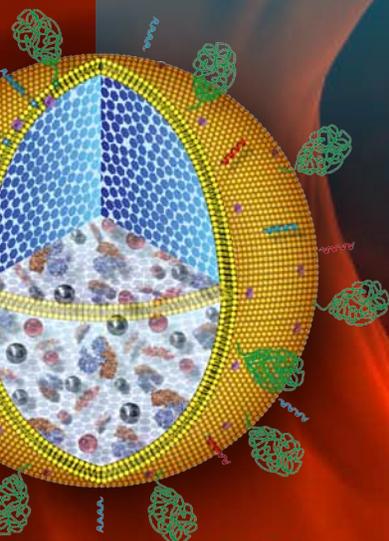
Work is also focused on creating a cost-efficient heliostat collector that has potential for distributed power generation from 50 to 2000 kW. Heliostats reflect sunlight at a solar tower or receiver that collects the energy. From the receiver, the thermal energy is used to heat a fluid (e.g., air, CO<sub>2</sub>, steam), which then turns a turbine generator that makes electricity.

Sandia researchers will also help develop test methodologies that will be used in the creation of highly absorptive solar receiver coatings with low thermal emittance to improve the thermal efficiency of the receivers.

By collaborating through SERIIUS, India and the United States are achieving the objective of high impact research and development that will overcome key technical barriers in solar electricity generation. This helps both countries achieve their solar energy goals.

“Our collaboration is focused on solving a “grand challenge” in cancer medicine: how to improve the therapeutic efficacy and reduce the systemic toxicity of cancer drugs by delivering them directly to cancer cells with novel nanodevices.”

**Dr. Cheryl Willman, M.D.**  
Director and CEO  
UNM Cancer Center



■ A protocell is a hybrid particle made up of a porous silica nanoparticle core coated with a fluid lipid bilayer membrane containing small peptides that are targeted to proteins selectively expressed on cancer cells.

# Improving on Nanoparticle-Based Drug Delivery by a Millionfold

Collaborations between Sandia National Laboratories and the University of New Mexico (UNM) Cancer Center have resulted in a novel targeted nanoparticle called a protocell which can more effectively deliver drugs to targeted cancer cells. It has been shown to improve upon existing nanoparticle-based drug delivery by a millionfold.

A hybrid particle made up of a lipid membrane and a porous silica nanoparticle core, the protocell combines key properties of each material. This allows it to deliver chemotherapy drugs to cancer cells while limiting side effects, including damage to normal cells. The protocell is also the ideal vehicle to deliver the custom drug combinations needed for personalized medicine.

This joint research is part of Sandia's University Partnerships Program, which strives to establish enduring partnerships at a focused set of universities to nurture talent, collaborative research, and national advocacy. Sandia also offers the Truman Fellowship for new PhD scientists and engineers who have been recognized for impact in their field.

The Sandia-UNM collaboration, led by Dr. Jeffrey Brinker, Sandia Fellow and Distinguished and Regent's Professor of UNM, and Dr. Cheryl Willman, M.D., Director and CEO of the UNM Cancer Center, is also supported by funding from the National Cancer Institute through its Nanotechnology Alliance. These programs all have a goal of conducting nanoscience as well as developing talent by involving students, including those in undergraduate, graduate, and postdoctoral programs.

Dr. Carlee Ashley, a Harry S. Truman Fellow in Biotechnology and Bioengineering at Sandia, worked with Brinker, Willman, and Dr. Eric Carnes, Principal Member of Technical Staff in Nanobiology at Sandia, as well as other team members, including UNM students, to develop the protocells. Brinker, Willman, Ashley, and Carnes are also working to start a new company based on the Sandia-UNM protocell technology.

Ashley was a doctoral student in Brinker's lab when she saw his work in encapsulating porous silica nanoparticles in lipid layers and came up with the innovative idea of incorporating targeting molecules that recognize cancer cells to adapt this technology for cancer drug delivery. A daunting engineering challenge, by combining the expertise of UNM in medical research and Sandia in materials science and nanotechnology, the development of the protocell was made possible.

The Sandia-UNM team has moved its research into various animal models, and is in the process of developing collaborations with local veterinary oncologists to use protocells for the treatment of canine leukemia and lymphoma. This is the next step along the road to approval of protocells for drug delivery in humans by the U.S. Food and Drug Administration.

In addition to performing pre-clinical studies of protocells targeted to cancer, the Sandia-UNM team is also extending the protocell technology to the prevention and treatment of infectious disease. The team's experience with cancer has enabled them to rapidly develop protocells for delivery of antibiotics and antivirals, which promises to substantially impact Sandia's national security mission.

## Growth of the Park Fueled by Numerous New Tenants

This year a number of new companies and organizations moved into the Sandia Science & Technology Park (SS&TP). They have found that the Park's location adjacent to Sandia National Laboratories makes it easy for them to do business with the Labs.

### Cyber Engineering Research Laboratory (CERL)

The Cyber Engineering Research Institute (CERI) is a virtual organization spanning Sandia's two main sites. CERI includes two facilities: CERL in the SS&TP, and the Cyber Technology Research Laboratory (CTRL) in the Livermore Valley Open Campus. CERL was established outside of Sandia's gates to build a cyber research community and facilitate hosting of collaborators. The facility houses a human performance lab, innovation lab, and research center.

### Global Analytic IT Services (GAITS)

GAITS provides the IT expertise and solutions clients need to succeed in achieving their energy, security/information assurance, homeland security, and defense missions. GAITS professionals support systems development and integration, science and engineering, test and evaluation, and Green IT objectives.

### Mazda Computing

A value-added system integrator of hardware and software solutions, Mazda Computing's

engineering expertise, ISO 9002 manufacturing facilities, and strong technology partnerships with industry leaders allow them to offer cost-effective IT solutions geared towards performance and reliability.

### RED, Inc. Communications (RED, Inc.)

A full-service multimedia development company, RED, Inc. specializes in technical writing/editing, document layout/production management, graphic design, web design/development, 3-D modeling, and video production.

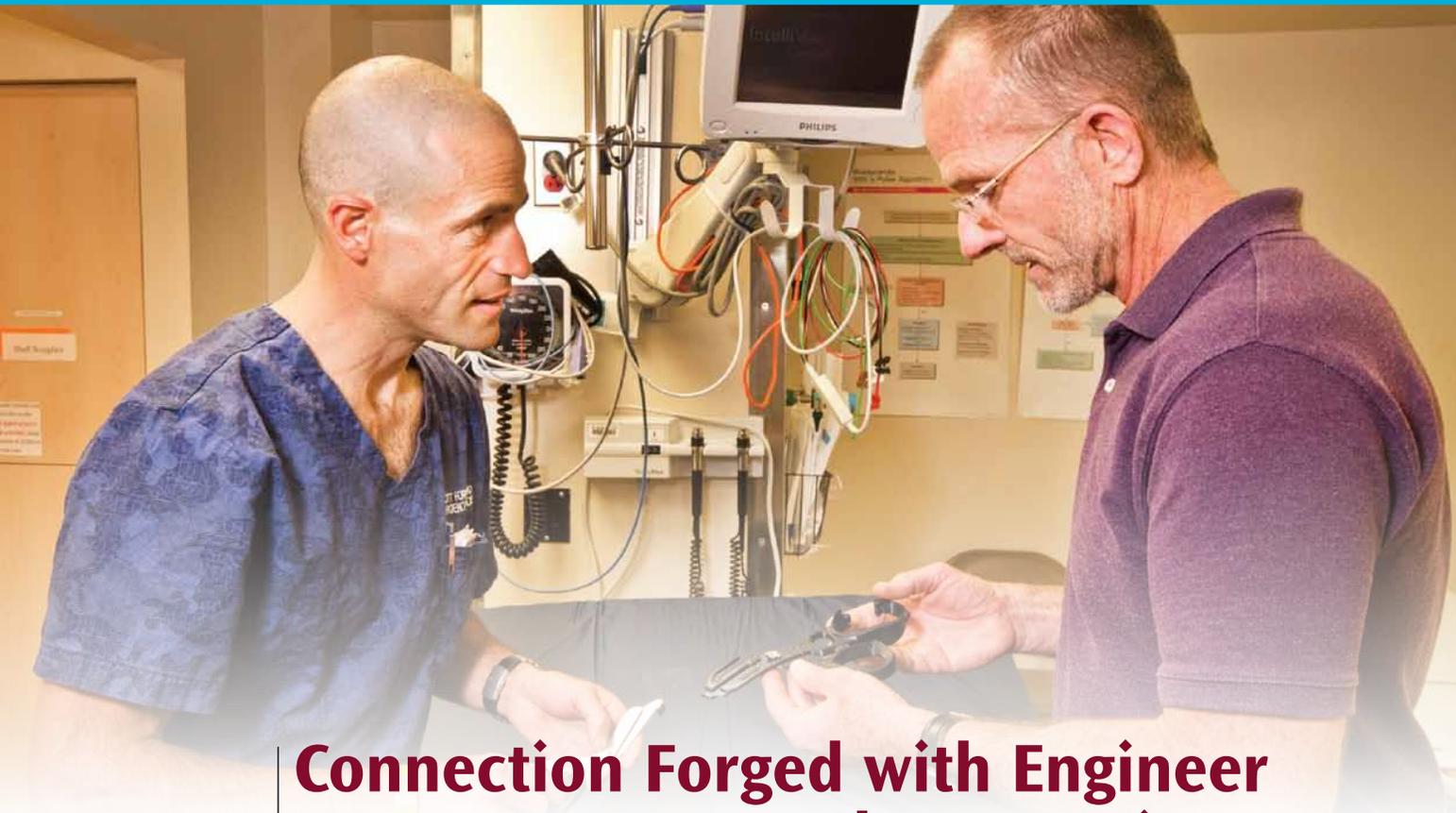
### Sumitomo Electric Device Innovations USA (SEDU)

The Albuquerque SEDU VCSEL Operations group designs and manufactures semiconductor laser and photodiode based products for data communications markets. SEDU is a wholly owned subsidiary of Sumitomo Electric Industries (SEI), Ltd., a leading provider of optical components and modules and RF high power wireless solutions for the global communications marketplace.

### The QC Group

The QC Group offers quality-related services including dimensional inspection measurements in their A2LA accredited laboratory, reverse engineering with scanning, 3D CAD modeling of legacy tooling and products, color map deviations to CAD, and quality-related training and staffing.





## Connection Forged with Engineer Improves Trauma Shears Design

■ Albuquerque emergency room physician and CEO Scott Forman and Sandia researcher Mark Reece (right) examine trauma shears developed for Forman's company, Héros.

“Our plan is to have our trauma shears-based multi-tool product enter the market in 2013,” says Scott Forman, emergency room physician and CEO of the Albuquerque startup Héros. Forman gives credit to the New Mexico Small Business Assistance (NMSBA) Program and Sandia National Laboratories engineer Mark Reece for helping improve the design of his company's first product, bringing his dream of defining a new paradigm for a common emergency responder tool closer to reality.

A lifelong tinkerer, as well as a medical doctor, Forman was frustrated that trauma shears frequently got lost, so he made his own that incorporated a carabiner for clipping to scrubs. Colleagues who saw the uniquely designed shears wanted a pair, so he began making them in his garage. After selling over 1,000 shears, he decided to improve on other aspects of the tool, and he applied to the NMSBA Program to get help with the blade design.

Emergency personnel have to cut through a variety of types of materials, from Kevlar, fiberglass, and plaster, to T-shirts and gauze. None of the existing trauma shears consistently cut through synthetics or dense materials very well. Reece, of Sandia's Multiscale Metallurgical Science & Technology group, studied and tested. He researched scissor blades used in various industries, and even the teeth of sharks, before developing an optimized blade design and serration pattern.

Forman calls Reece's design work, which resulted in a patent-pending blade manufactured of high carbon surgical stainless steel, “meticulous” and “brilliant.”

The company founder promises that the Héros multi-tool is just the first product in the pipeline. Forman is looking forward to working with Reece again through the NMSBA Program, which allows Sandia to provide small businesses in New Mexico with assistance from laboratory experts to help solve technical challenges.

## Three Sandians Venture Out to the Private Sector

Entrepreneurial Separation to Transfer Technology (ESTT) is a valuable tool for Sandia National Laboratories to transfer technology to the private sector, allowing Sandia employees to leave the Labs in order to start up new technology companies or help expand existing companies. Entrepreneurs are guaranteed reinstatement by Sandia if they choose to return to the Labs before ESTT expiration.

This year three Sandia employees utilized ESTT.

■  
**Gregory Sommer,** former Senior Member of Technical Staff at Sandia, now co-founder of Sandstone Diagnostics, works on developing the SpinDx point of care clinical diagnostic platform.

Paula Sue Downes started a new company, PRISM Analytics Corporation. She is providing products and services that advance data-intensive predictive analysis in the investment, business logistics, and business risk arenas. During her years at Sandia, Downes gained advanced expertise in modeling, simulation, and analysis. Her ESTT participation is helping to transfer government-funded technology created to assist U.S. companies with homeland security issues to the private sector.

Gregory Sommer co-founded a startup company, Sandstone Diagnostics. The company is licensing Sandia's SpinDx technology, which he co-invented, and is developing commercial diagnostics instrumentation for clinical and life science research markets. Sommer and his team are focused on advanced R&D of the technology and pursuing SBIR grant and private investment opportunities. Success of his venture will translate Sandia's biodefense technology to the burgeoning point-of-care diagnostics market.

Benjamin Welch joined Dynamic Systems and Research (DSR) as electrical engineer. The company's plans for expansion call for transitioning their products from R&D projects to the marketplace. DSR performs a majority of its work for the Department of Defense (DoD), and Welch's unique skill set of developing and deploying embedded products will expedite the company's growth.





## Community Collaborations Flourish at California Campus

■ Rick Stulen, Sandia/California Vice President (retired), listens as Rob Lamkin (right), CEO of Livermore-based Cool Earth Solar, describes his company's inflated, concentrated photovoltaic technology.

Spanning the east side of Sandia National Laboratories and Lawrence Livermore National Laboratory, the Livermore Valley Open Campus (LVOC) is a recent joint initiative that is enabling partnerships with academia, industry, and the community. This 110-acre open campus supports collaboration with the local and international science and technology community, while attracting the next generation of top talent. It gives partners ready access to world-renowned facilities and collaborative spaces where they can work with Lab researchers in areas such as bioscience, cyber security, energy technologies, and hydrogen applications.

One of the anchor facilities at the LVOC is Sandia's Combustion Research Facility (CRF). As a U.S. Department of Energy (DOE) Office of Science collaborative research facility, a key aspect of the CRF's mission is to encourage the direct involvement of collaborators from the scientific community. The CRF also works with industrial partners. For example, the CRF has been working closely with U.S. engine manufacturers for more

than 30 years to increase scientific understanding of internal combustion engine processes affecting efficiency and emissions.

Another project at the LVOC is being enabled by a Cooperative Research and Development Agreement (CRADA). Cool Earth Solar will use five acres of the LVOC as a pilot site for their low-cost concentrated photovoltaic (PV) technology. Cool Earth technology is "reshaping solar energy" by embossing optics onto thin films that are inflated into tube-shaped solar concentrators that focus intensified sunlight onto PV cells. As part of the CRADA, the company will provide equipment and personnel to operate and maintain the PV systems while Sandia will provide PV system engineering and testing expertise.

In addition to all the programs and facilities that allow scientific collaboration, the LVOC has become the site of a Farmer's Market called Fresh @ the Labs. This community event includes local food vendors, entertainment, and education booths to encourage healthy lifestyles.

## VC Funding Allows Sandia VCSEL Technology to Shine

Gary Oppedahl's vision is to grow New Mexico into the world's premier optoelectronics epicenter which will create jobs and retain local talent. The serial entrepreneur, who was part of MicroOptical Devices (MODE), a successful startup company later purchased by EMCORE, is now at the helm of another startup, TriLumina.

Like MODE, TriLumina is based on vertical cavity surface-emitting laser (VCSEL) technology originally developed at Sandia National Laboratories. John Joseph, a former Sandian, came up with a way to dramatically improve on the tiny semiconductor laser's speed and power. He founded TriLumina to commercialize his patented breakthrough.

Individually, VCSELs are low power, so signals can only travel long distances through fiber optics. Joseph came up with a way to create a powerful 2D array of VCSELs which can send signals through the air, letting data travel long distances very quickly, without any cables.

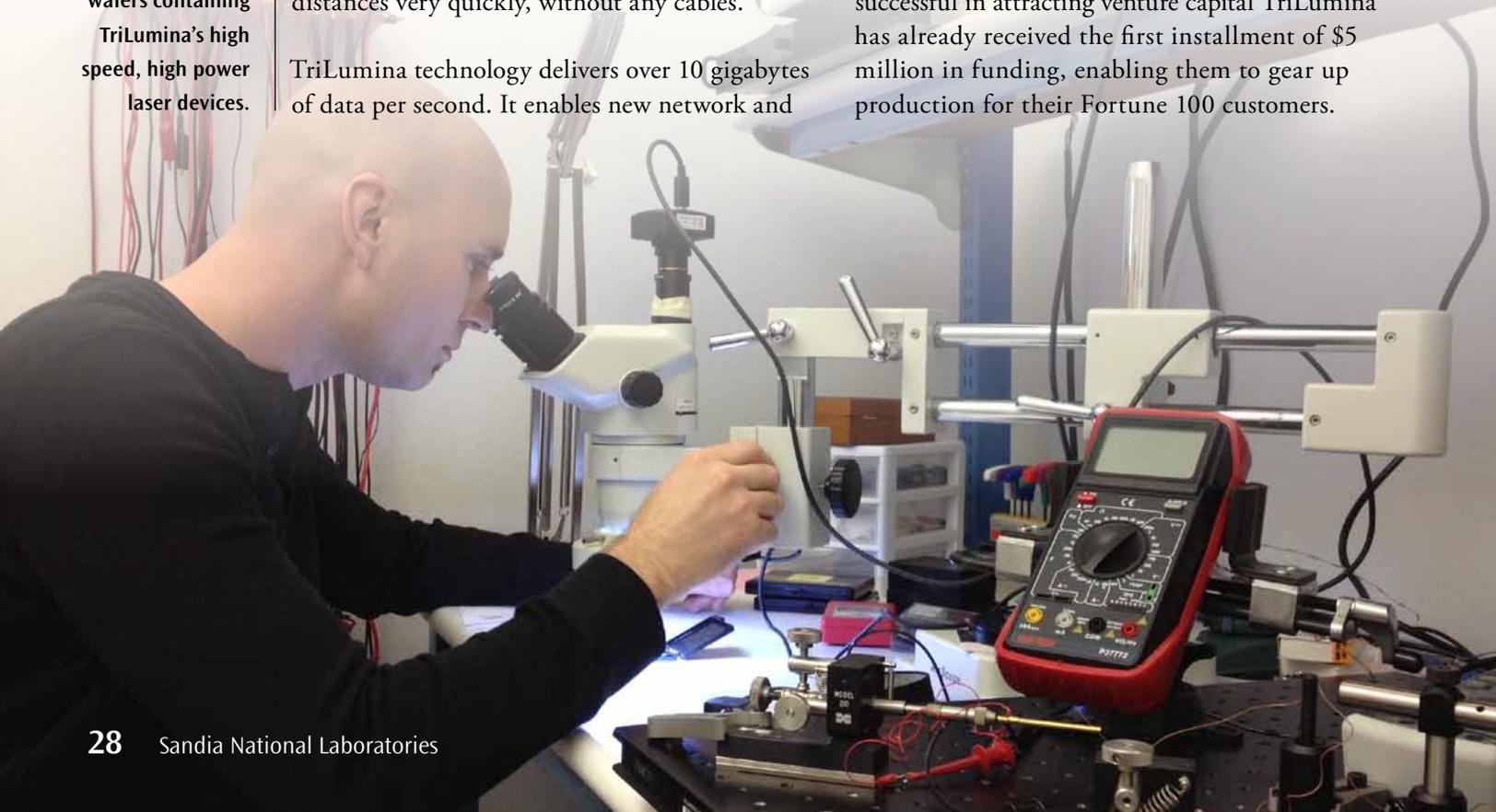
TriLumina technology delivers over 10 gigabytes of data per second. It enables new network and

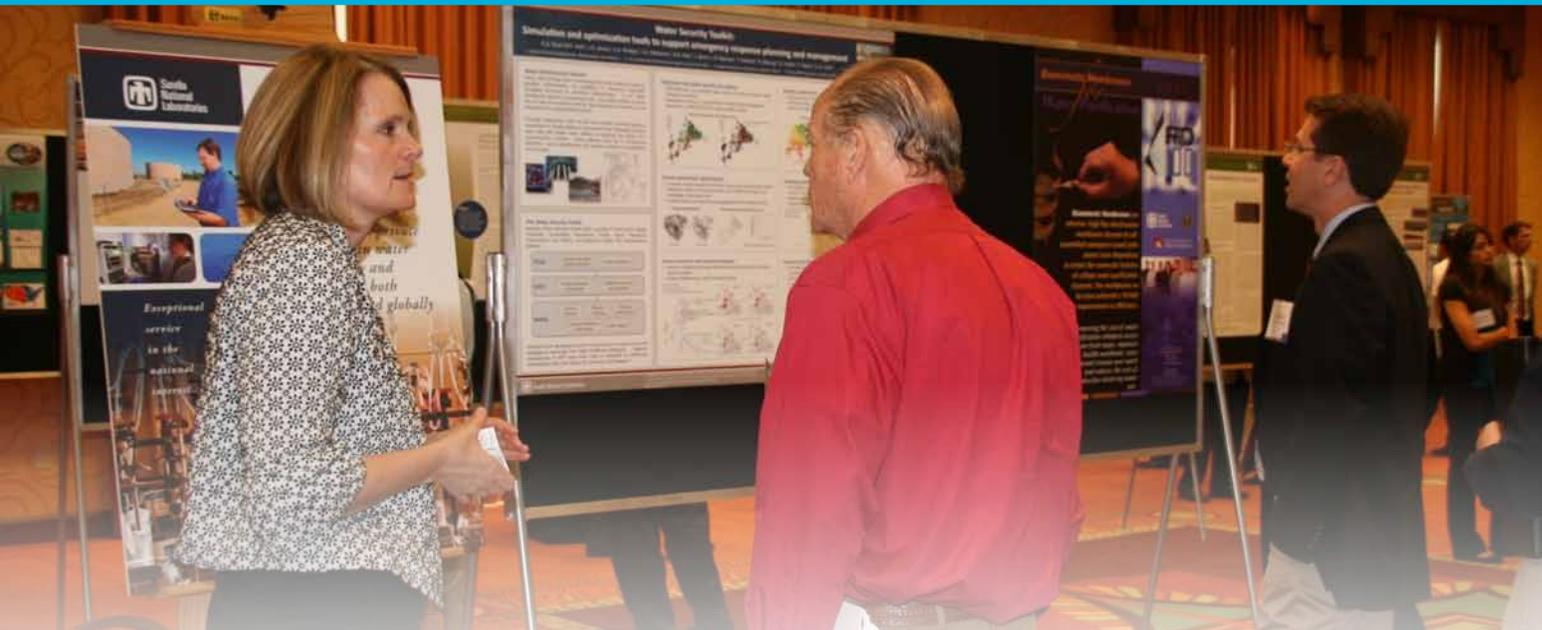
satellite communication capabilities and natural user interfaces (using machine vision). Potential applications include connecting any networked device wirelessly at fiber optic speeds.

The team at TriLumina brings together a number of ex-Sandians in addition to Joseph. Oppedahl feels that the technical expertise they possess is crucial, and is complemented by the commercialization skillsets of others at the company. He has learned through experience that to produce a disruptive product, marketing and customer relationships, in addition to technology, are fundamental.

Oppedahl was a presenter at the 2012 Technology Ventures Corporation Deal Stream Summit, seeking investment in TriLumina. The organization helps create jobs by optimizing ideas, talent, and capital in communities served by U.S. Department of Energy (DOE) laboratories. Just as when he presented previously for MODE, Oppedahl was successful in attracting venture capital. TriLumina has already received the first installment of \$5 million in funding, enabling them to gear up production for their Fortune 100 customers.

■  
Alex Joseph, son of inventor and ex-Sandian, John Joseph, inspects new wafers containing TriLumina's high speed, high power laser devices.





## Sharing Technologies and Ways to Do Business with the Labs

■ **Maelyn Melville,** Technical Business Development Specialist, explains available technologies to a Showcase attendee at a poster session.

On September 12, 2012, Sandia National Laboratories hosted its first annual Research & Technology Showcase. Organized by the Sandia Science & Technology Park (SS&TP) Program Office, the free, day-long event was designed to present cutting-edge research and technology development at Sandia, and technology partnership success stories. Information about how to do business with the Labs through licensing partnerships, procurement, and economic development programs was also provided.

“Tech transfer is a Sandia mission requirement,” said Sandia President and Laboratories Director Paul Himmert, who opened the Showcase in Albuquerque. “We want to leverage research dollars for economic growth, and the community is a key partner.”

Pete Atherton, Senior Manager of Industry Partnerships, told the audience about a few of the many Sandia technologies available for immediate licensing, and gave examples of companies that had successfully licensed technologies, with products already in the marketplace.

In addition to the focus on how to do business with Sandia, the Showcase highlighted four technical aspects of Sandia’s work: cyber research, energy security, nano and microsystems, and water security. Individual speakers, panel discussions, poster sessions, and booths were used to present information to participants. Speakers included Sandians, elected officials, and business leaders.

The event attracted nearly 400 attendees who included industry representatives from throughout New Mexico as well as companies from Arizona, California, Colorado, Illinois, Maryland, Massachusetts, Nevada, New York, Texas, and Utah. Academic representatives from a number of universities were also present.

The Showcase generated 21 New Mexico Small Business Assistance program prospects, four new SS&TP prospects, one sign-and-drive license, and multiple supplier and partner prospects. Sponsors included the City of Albuquerque, Bernalillo County, Sandia, SS&TP, and Technology Ventures Corporation.



## Recognition

Once again this year, Sandia National Laboratories celebrated at events which honored innovation and entrepreneurial spirit.

### Innovation and Intellectual Property Celebrations

Events were held in New Mexico and California to recognize Sandia scientists and engineers whose work created intellectual property (IP). These celebrations paid tribute to Sandians who received patents, copyrights, royalties, Classified Intellectual Property Awards, or special awards. Their IP has contributed to Sandia's IP and licensing portfolios, royalty streams, and outstanding reputation in innovation and technology transfer.

Up-and-Coming Innovators were also recognized. This award recognizes individuals who displayed enormous potential for supporting impactful innovations, exhibited entrepreneurial talent, and developed unique solutions to complex scientific challenges.

During the celebration in New Mexico, held at the BioPark Aquarium in Albuquerque, Sandia recognized 77 patent holders, 23 copyright authors, and 28 Up-and-Coming Innovators. At the 15th

annual celebration in California, 16 patent holders, 13 copyright authors, 13 classified inventors, 36 royalty recipients, and 6 special award recipients were recognized. Besides the creation of IP, the achievements of Sandia personnel often result in recognition such as R&D 100 Awards and election into, or recognition of lifetime achievements by, technical professional societies.

### Entrepreneurial Spirit Awards Luncheon

At the third annual event, sponsored by Technology Ventures Corporation, three Sandia entrepreneurs were honored: Laurence Brown, Mathew Donnelly, and James Pacheco. This award is presented annually to entrepreneurs who left Sandia permanently and achieved success, as well as to entrepreneurs who returned to Sandia with valuable experience gained in the private sector.

### NMSBA Innovation Celebration

Ten New Mexico Small Business Assistance (NMSBA) Program projects were showcased at this annual event, including four where technical assistance was received from Sandia: Albuquerque Delicate Dentistry, Improving Livestock Health, Musicode Innovations, and SAVSU Technologies.



## Awards

### R&D 100 Awards

- **Neutristor:** A computer chip configuration for neutron generators, the ultracompact neutron generator is 1,000 times smaller than anything on the market with potential medical and industrial applications.
- **Sandia Cooler:** An air bearing heat exchanger, which will significantly reduce the energy needed to cool processor chips in data centers.
- **Microsystems-enabled Photovoltaics:** Combines mature technology and microsystem production. The cells can achieve higher circuit voltages and have potential applications for clothes, buildings, portable electronics and vehicles.
- **Digital Microfluidic Hub:** Preparation of nucleic acid libraries for ultra-high-throughput sequencing with a digital microfluid hub. The technology builds on Sandia's rapid threat organism recognition effort and identifies and characterizes unknown pathogens.

### Federal Laboratory Consortium (FLC) National Awards

- **Excellence in Technology Transfer Award: Fuel Cell Mobile Light**  
The Fuel Cell Mobile Light helps bring clean hydrogen fuel cell lighting products to industry. In doing so, Sandia is helping our nation to reduce diesel and greenhouse gas emissions, and lower our dependence on foreign oil.
- **State and Local Economic Development Award: Sandia Science & Technology Park**  
A partnership between the Labs and public and private partners, the SS&TP is adjacent to Sandia. SS&TP's mature companies and startups collaborate with Sandia on an assortment of technologies, products, and services.

### FLC Mid-Continent Region Awards

- **Excellence in Technology Transfer Award: Crystalline Silico-Titanates (CSTs)**  
Patented CST technology, licensed from Sandia by Honeywell UOP, is being used for cleanup of radiation-contaminated water at the Fukushima Daiichi nuclear power plant in Japan.
- **Notable Technology Development Award: Biomimetic Membranes**  
Nearly half the world's population has inadequate access to clean water. Biomimetic membranes, a revolutionary advance in the field of membrane technology for water filtration, can increase access to clean water by dramatically reducing energy use and costs.
- **Outstanding Partnership Award: i-GATE**  
The i-GATE (Innovation for Green Advanced Transportation Excellence) regional public-private partnership supports small businesses and maximizes the economic potential of green transportation and clean-energy technologies. i-GATE creates a two-way link between national laboratories and industry.
- **Honorable Mention for Notable Technology Development Award: Dakota Software**  
Engineers often need computational simulations to solve scientific problems. Dakota is an open-source software tool that helps researchers assess their simulations' accuracy, shortening design cycles, and cutting development costs.

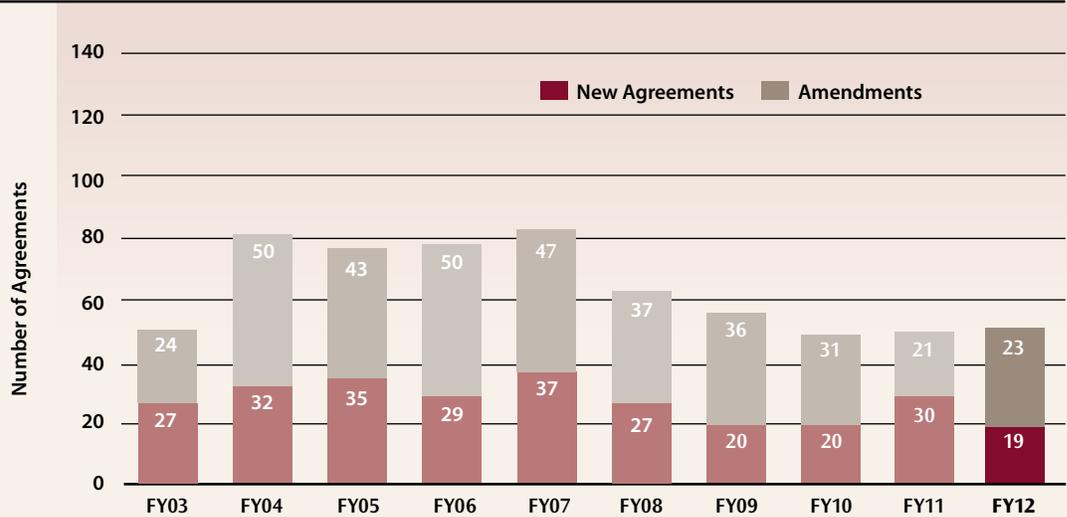
### Manufacturing Extension Partnership (MEP) National Award

- **Manufacturing Advocate of the Year: New Mexico Small Business Assistance (NMSBA) Program**  
The NMSBA was recognized with this award from MEP under the U.S. Department of Commerce for its "commitment to the business growth and transformation of U.S.-based manufacturing through work in the manufacturing sector."

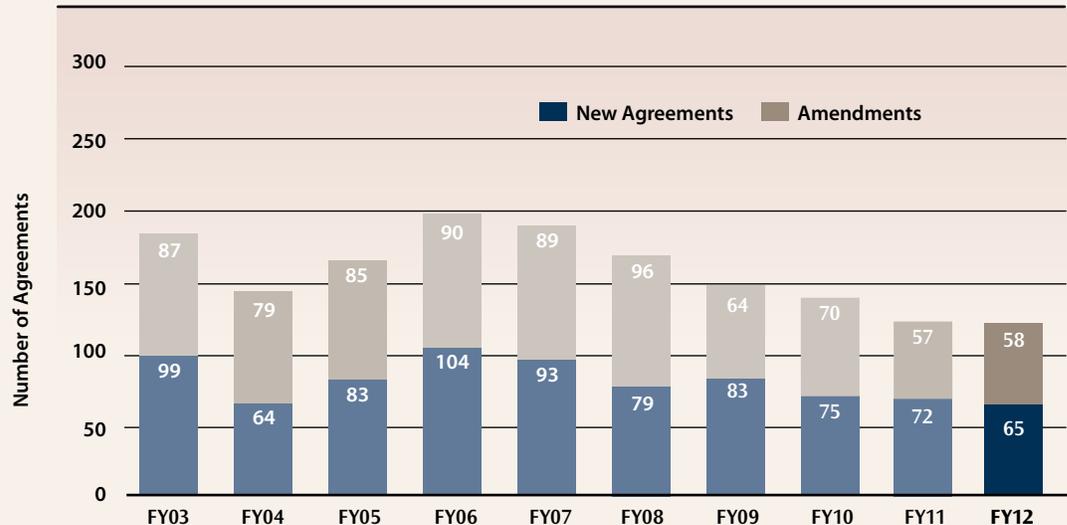
The Partnerships Program maintains a performance measurement system, summarized in this section. Included is data which has been compiled for specific program metrics that are updated annually.

## CRADAs and WFO-Industrial

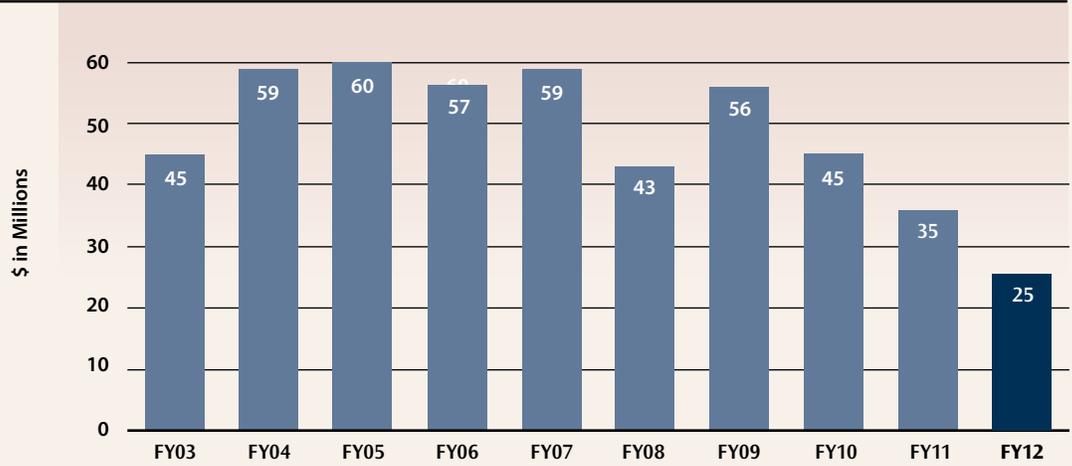
### Sandia CRADA Program Activity



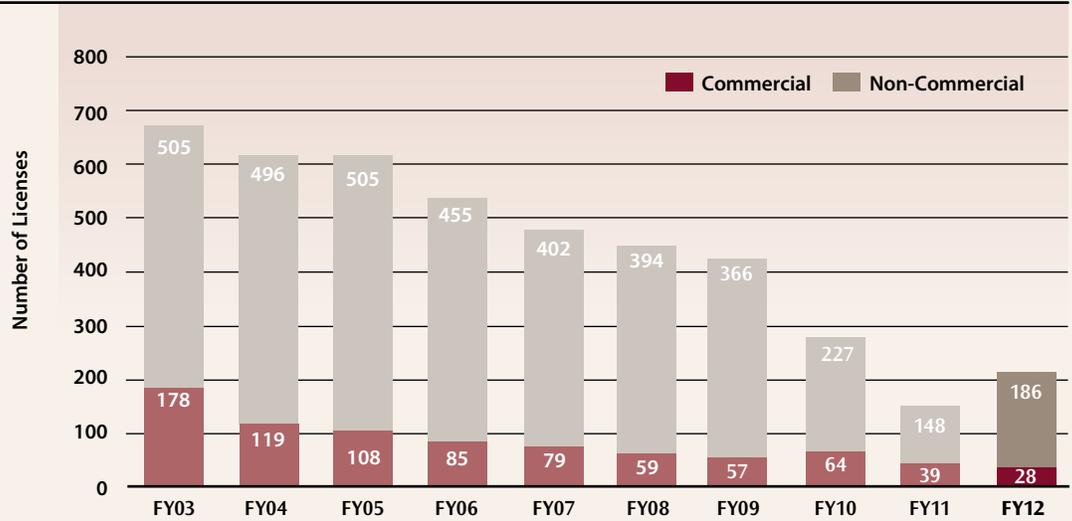
### Sandia WFO-Industrial Partners Activity



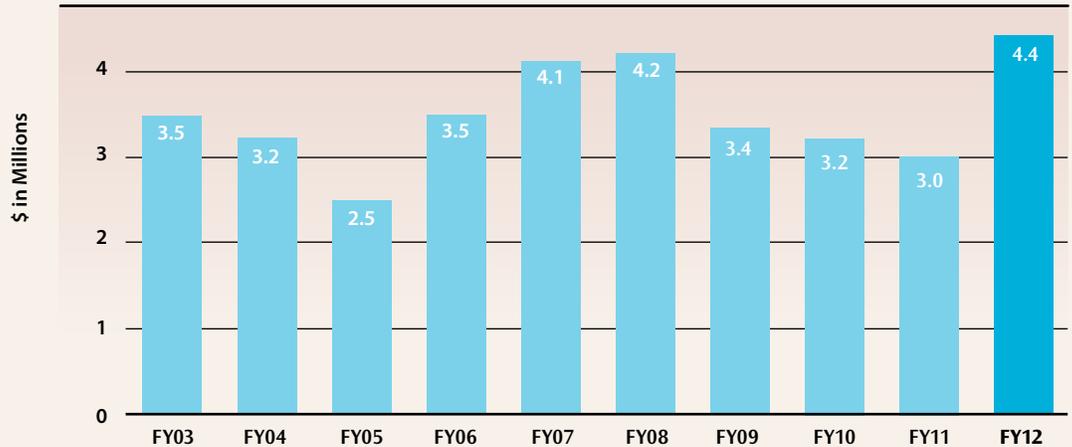
## Industry Funds-In to Sandia (\$M)



## Licenses

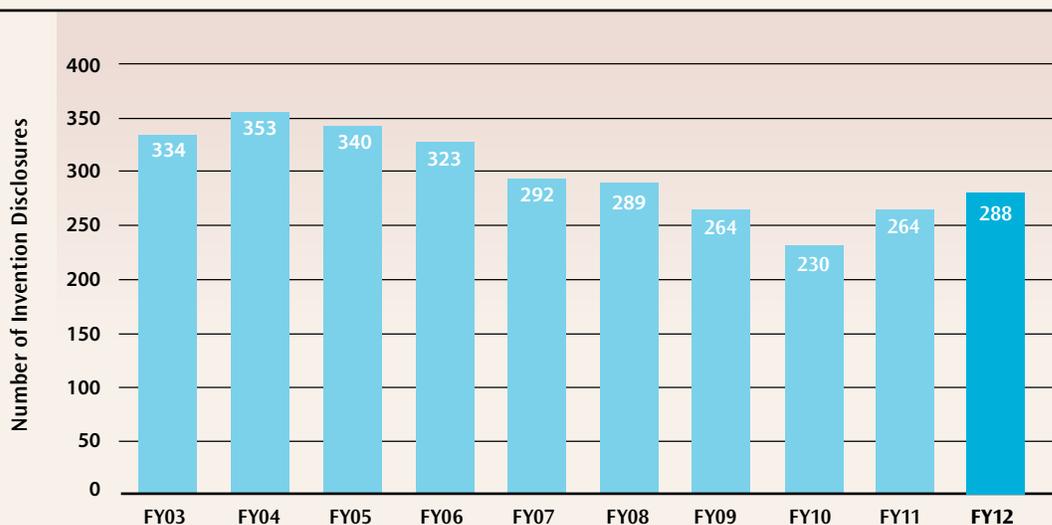


## Licensing Income (\$M)

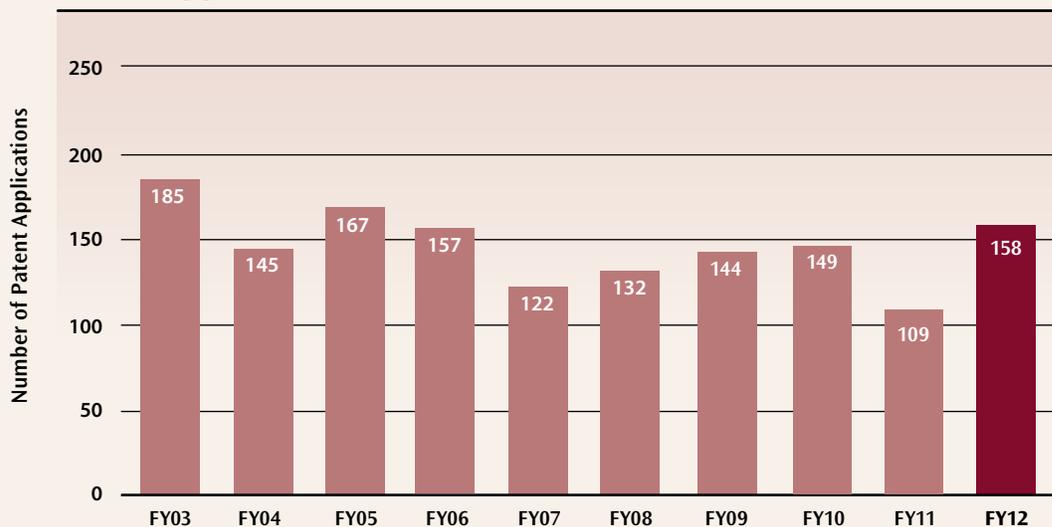


## Patent Activity

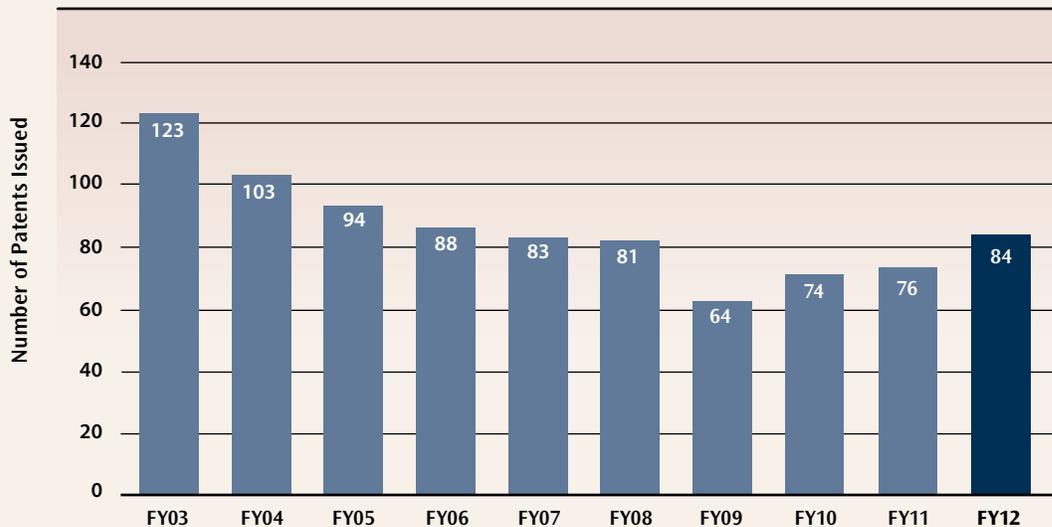
### Invention Disclosures



### Patent Applications



### Patents Issued





## Sandia Science & Technology Park (SS&TP)

### Results

Companies and Organizations	33
Employees	2414
Buildings	24
Available Space (out of 1.1 Million sq. ft.)	96,206
Available Land (out of 340 acres)	228
Funds-In to Sandia from Park Companies*	\$17.7M
Contracts from Procurement to Park Companies*	\$402M
Contracts Between Park Companies*	\$9.7M
Public Investment in the Park*	\$89M
Private Investment in the Park*	\$269M
Total Investment in the Park*	\$358M
Average Salary of Full-time Jobs in Park	\$75K
Average Salary of Full-time Jobs in Metro Albuquerque	\$42K

\*Since Park opened in 1998.



## New Mexico Small Business Assistance (NMSBA) Program

In 2012 the state of New Mexico, along with LANL and SNL, invested **\$4.5M** to help **349** small businesses in **27** counties solve technical challenges.

	<b>2000 - 2012</b>
<b>New Mexico Small Businesses Assisted</b>	<b>2036</b>
<b>Rural vs Urban Businesses</b>	
Rural (65%)	1329
Urban (35%)	707
Combined	2036
<b>Dollar Amount of Assistance</b>	<b>\$34.3M</b>
	<b>2000 - 2011</b>
<b>Return on Investment (ROI)</b>	<b>1.18</b>
<i>(ROI is Based on Salaries of Jobs Created and Retained)</i>	
<b>Economic Impact</b>	
Small Business Jobs Created and Retained	2874
Mean Salary	\$39K
Increase in Revenue	\$145.2M
Small Business Decrease in Operating Costs	\$72.6M
Investment in NM Goods/Services	\$43.3M
New Funding/Financing Received	\$52.3M



## Entrepreneurial Separation to Transfer Technology (ESTT) Program

<b>Sandia Scientists and Engineers Who Left on ESTT*</b>	<b>142</b>
To Start Companies	57
To Expand Companies	85
<b>Companies Impacted by ESTT*</b>	<b>95</b>
Start-ups	46
Expansions	49
<b>Licenses for Sandia IP Negotiated with ESTT Companies</b>	<b>43</b>

\*Since ESTT began in 1994.

For more than two decades, Sandia National Laboratories has worked closely with industry, universities, and government agencies to bring new technologies to the marketplace.

**For general questions or comments, contact [partnerships@sandia.gov](mailto:partnerships@sandia.gov), or call 505-284-2001.**

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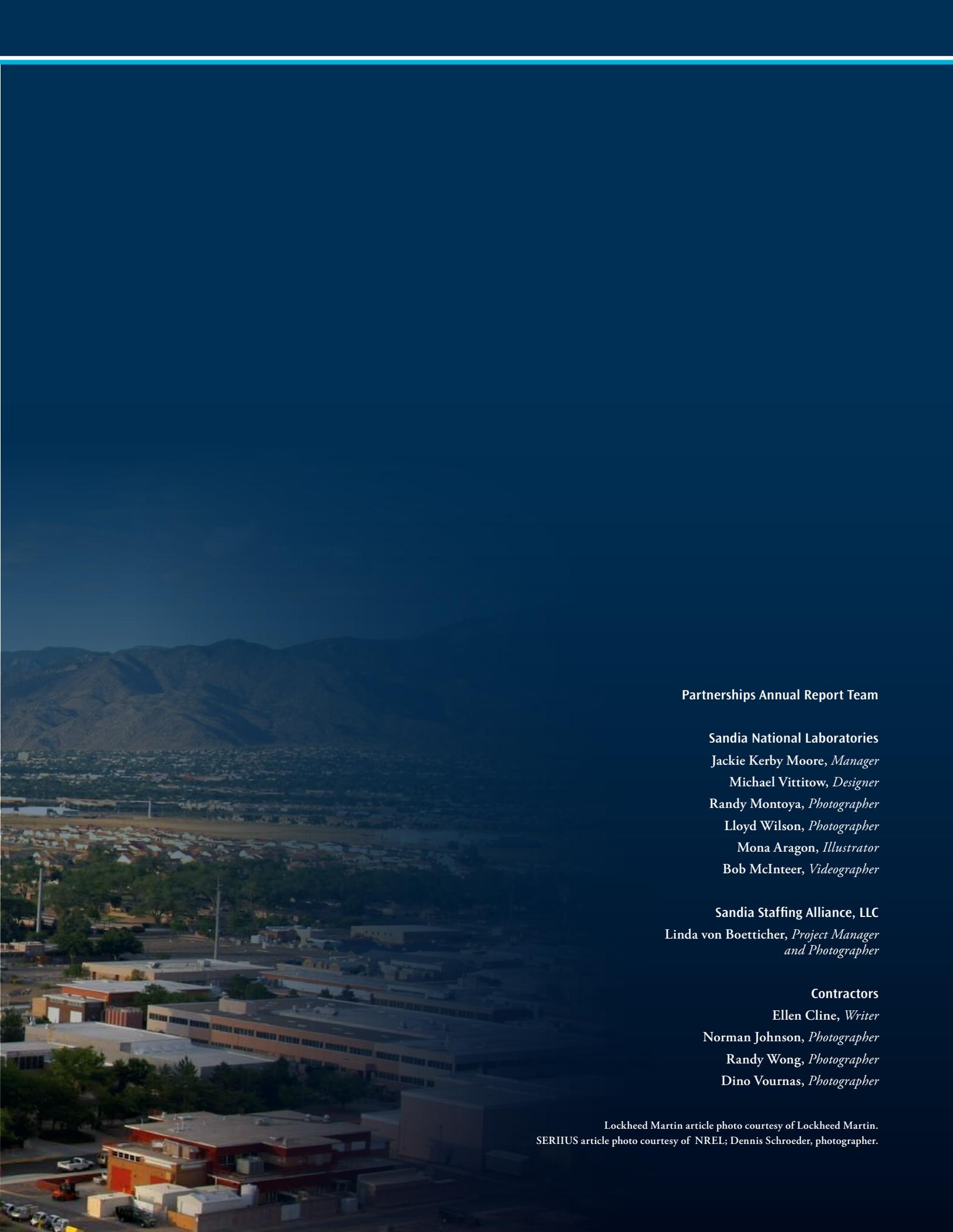
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*Founded in 1993 by Lockheed Martin, Technology Ventures Corporation's charter is to facilitate the commercialization of technologies developed at Sandia, other laboratories, and research universities.*



**Partnerships Annual Report Team**

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Dino Vournas, *Photographer*

Lockheed Martin article photo courtesy of Lockheed Martin.  
SERIUS article photo courtesy of NREL; Dennis Schroeder, photographer.



**Sandia  
National  
Laboratories**

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**505-284-2001**

**[www.sandia.gov/partnerships](http://www.sandia.gov/partnerships)**



**U.S. DEPARTMENT OF  
ENERGY**

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SAND number:2013-1982P.